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Abstract

This paper examines the relationship between the biopsychosocial model and cerebral palsy. Using the biopsychosocial model, the symptoms, prevalence, etiology, and management of cerebral palsy will all be examined under biological, social and psychological lenses to better understand the disorder. Each individual aspect will be used to draw connections across fields of study, resulting in a full picture analysis that can be used to better treat unique cases of cerebral palsy. This information may also be used to better educate and therefore minimize known risk factors. This paper predominately uses scholarly articles from scientific databases like Medline and PsychInfo.

Cerebral Palsy and The Biopsychosocial Model: Finding a Comprehensive Solution.

The dominant model of medicine that is currently used by today's practitioners is a biomedical model, otherwise known as the medical model. This model emphasizes the physical and biological aspects of a disease and treatment, contributing to the rushed, atmosphere of today's doctor's offices and emergency rooms where patients are often seen as a checklist of symptoms. This has been the model of medicine dating back to the mid-19th century. However, the literature is beginning to point in a new direction, one that encompasses more aspects of life in an effort to create a fuller picture of the patient and their ailments. This new direction is the biopsychosocial model (BPS Model). This model was developed by a psychiatrist named George Engel in 1977. Engel introduced the model as a criticism of the current biomedical model and as a call to action for a more inclusive healthcare model (Engle, 1977).

Unlike the biomedical model the BPS model considers not only the physical and biological factors that relate to disease, but also the psychological and social factors that can have effects on the development and course of diseases and illnesses. Recently, the BPS model has been extended to an ecological model that highlights not only the importance of biological, psychological, and social influences, but the inherent interaction of these factors in determining health and disease (Maier & al'Absi, 2017). The more researchers learn about how the environment impacts a person's body, the more the BPS model seems to be the better fit. More specifically, a biopsychological paradigm has also been proposed (Stineman, & Streim, 2010). It is similar to the BPS model in the placement of its foundational importance on the interrelatedness and multifold connections found within different levels of disease and treatment, but it is focused on mobility-related problems in

particular. Cerebral Palsy (CP) is one of those disorders that can be best understood from these broader frameworks.

Despite the fact that CP is one of the most prevalent disorders in the childhood population (Herskind, Greisen, & Nielsen, 2015), research has not identified a primary cause. There are multiple theories and correlations between risk factors and the occurrence of CP, but a comprehensive understanding of the disorder is lacking. The same can be said for the severity, treatment and prognosis of the disorder. This may be in part because up until very recently the biomedical model was the default in evaluating disease and disorders. With new research however, the scientific community has found several meaningful risk factors, quality of life indicators, and influences on prognosis from psychological and social domains that are neglected by the biomedical model. The shift towards the BPS model has the potential to identify more direct relations between the seemingly unlimited factors that play a role in affecting people with CP.

If one was to evaluate what is already known about CP through the lens of the BPS model what new understanding can we gain by considering more than just the biological side? With this transition comes the need to reevaluate what was previously known under this new light. In doing so one can not only paint a clearer picture of the causes of CP, but also determine the best treatment plans to maximize life expectancy and quality of life. There is plenty of research currently available that evaluates different aspects of CP including the possible causes, risk factors, and some suggested or trial treatment programs. Unfortunately, there are little to no connections between the independent studies in the current literature. With the hope of highlighting connections and relationships between the different aspects of CP, studies from all areas of the health literature will be analyzed with the biopsychosocial

perspective in mind. These studies will represent all stages of CP and add to the literature by drawing connections between biological, psychological, and social factors.

Description and Diagnosis

There are multiple layers, types, and severity to a CP diagnosis. For the purposes of this paper we will include studies that involve any or all forms of CP in an effort to be as comprehensive as possible. There are four subtypes of CP that are categorized by the area of the body that is affected and the neurological symptoms that are displayed (Batshaw, Roizen, & Lotrecchiano, 2014). The four subtypes described by Batshaw, Roizen, and Lotrecchiano (2014) are spastic, dyskinetic, ataxic, and mixed CP. Spastic CP is characterized by an abnormal increase in muscle tone resulting in overly tight muscles that are resistant to stretch. There are three subcategories for spastic CP. Spastic diplegia is when the person's arms are less affected than their legs. Spastic quadriplegia is characterized by motor impairments that affect all four limbs as well as the trunk and mouth, this is typically the most severe form of CP. Spastic hemiplegia is when only one side of the person's body is affected, this type tends to be milder. The remaining three overall subtypes are dyskinetic CP which is defined as CP that is accompanied by atypical movements or dyskinesias. The atypical movements may manifest in fast, slow, and involuntary forms. Ataxic CP is characterized by the patient's lack of postural control and inability to sustain certain posture positions. Lastly, mixed CP is the catch-all diagnosis that accounts for those who experience symptoms that are characteristic of more than one subtype of CP. Batshaw, Roizen, and Lotrecchiano (2014) suggest that CP is caused by some type of injury to the developing brain. Brain injury could include things like trauma and loss of oxygen. This however is not sufficient in creating an optimal treatment program because it neglects the psychological and

social wellbeing of the patient. There is enormous variation in the origin and cause of injury that more information is needed to accurately paint the whole etiological picture and the BPS model may help provide the missing information.

A typical diagnosis is made between one and two years of age, though a diagnosis at this age is extremely difficult due to a lack of parental knowledge surrounding the early warning signs (Herskind, et al., 2015). To add to the fact that few early signs or symptoms are known, those that are, are also quite easily missed. Some of the early signs that are described by Herskind, Greisen, and Nielsen, (2015) include ones that are subtler, such as a poor sucking ability, a continuously clenched fist, and a slower rate of head growth. Two more noticeable signs are delays in motor milestones and seizures. Children with CP are also more likely to be vulnerable to chronic pain as they tend to have a heightened sensitivity to pain (Riquelme, Padrón, Cifre, González-Roldán, & Montoya, 2014). Some research suggests that individuals with CP have abnormal brain processing of somatosensory stimulation which results in the increase in pain sensitivity (Riquelme, et al., 2014). As previously mentioned the severity of CP can vary greatly, therefore it takes a meticulous and trained eye to notice the subtleties that can lead to an early diagnosis. The earlier the diagnosis the better. An early diagnosis means that the child will be exposed to treatment sooner, often resulting in better outcomes. Earlier treatment also gives the practitioners more time to find the optimal treatment plan for that child. Many studies have found that the younger subjects tend to benefit more from the treatment. Unfortunately, due to the varying degrees of severity and areas of the body effected finding the right treatment program may include some trial and error. There is no prescription or course of treatment that fits all individuals. In the spirit of detecting CP as early as possible researchers have been looking

for ways to detect CP in utero (Herskind, et al., 2015). In fact, CP can be predicted before birth in severe cases with the use of magnetic resonance imaging and cranial ultrasounds (Herskind, et al., 2015).

According to Øberg, Jacobsen, and Jorgensen (2015) observed that the way a fetus moves can be a good indicator in determining the severity of the child's CP. Fidgety movements are abnormal general movements that can indicate the possibility of CP. Interestingly, the absence of general movements is just as strong of an indicator as the presence of fidgety movements. Other aspects of life that are affected by CP that are not directly associated with movement or posture are emotional and behavioral issues, hyperactivity, and interpersonal deficits (Yamaguchi, et al., 2014). Even though these may be attributed to another diagnosis they often accompany the more physical symptoms of CP and can help to confirm a diagnosis.

Prevalence and Prognosis

CP is known as the most ubiquitous pediatric motor disorder (Herskind, et al., 2015). There seem to be higher rates in preterm infants as opposed to full or post-term babies. Although, the effects of CP tend to be more severe in full-term infants (Mcintyre, et al., 2013). Prevalence rates seem to remain unchanging despite medical advancements (Day, 2011). In developed countries the prevalence rate is anywhere from 2 to 2.5 per 1000 children (Schiariti, Selb, Cieza & O'Donnell, 2015). Similarly, the occurrence of CP in preterm infants is 11.2 per 1000 live births (Oskoui, Coutinho, Dykeman, Jetté, & Pringsheim, 2013). There is a clear risk relationship between populations of low socioeconomic status and the occurrence rate of CP. Solaski, Majnemer, and Oskoui (2014) found that those with a lower socioeconomic status have a higher risk of having CP. The

relationship is not a direct causal association, and several mediators may be involved. For example, low birth weight may be a mediator between low socioeconomic and risk of CP. This is where the BPS model becomes important in identifying these mediators. Some studies in the United States have found that African American children have higher rates of CP than Caucasian children. However, after birth weight is taken into account the race difference balances out (Durkin, et al., 2015). This may be because of the connection between SES and birthweight (Solaski, Majnemer, & Oskoui, 2014). Another noteworthy statistic that can be found is in relation to gender. Males are 32 percent more likely to have CP than females (Durkin, et al., 2015).

Similar to how CP has varying levels of severity it makes sense that mortality and prognosis vary accordingly. There is a strong positive correlation between gross motor function (including maintaining feeding postures) and survival probability (Brooks, et al., 2014). When gender is accounted for, the statistics for males and females are different even if gross motor function is comparable. For example, females who were fifteen years old and able to walk unaided are estimated to have an additional 55 years of life. Whereas on the other hand, fifteen-year-old males who could walk unaided were only estimated to have an additional 52 years (Brooks, et al., 2014). This difference mimics the gender gap that can be seen in the average population where women have an average of approximately five additional years than men (Rochelle, Yeung, Bond, & Li, 2015). Though when it comes to severe forms of CP, Brooks and his team (2014) found that there does not seem to be a gender difference. Fifteen-year old's who required tube feedings and struggled to lift their head into the prone position were only estimated to have an additional 14 years. Children who could not lift their head into the prone position and therefore needed to be tube fed had

only a 21 percent chance of living to be age 30. This specific population also had a median age of death around 17 years old. As a whole, those who can walk unassisted and feed themselves have the best outlook and prognosis; about 94 percent of people in this category will live to be at least 30 years old which is comparable to the rate for the general population where 98.5 percent of people live to be at least 30 years of age. (Brooks, et al., 2014).

Etiology

The etiology of CP can be broken down into sections that line up with the three biopsychosocial perspective components, biological, social, and psychological. First are the biological aspects of CP etiology. Genetic susceptibility, injuries or disturbances to the fetal brain, and the following known risk factors are all components that either singularly or cumulatively result in CP: infants born preterm, intrauterine growth restriction (IUGR), infection while in utero (Korzeniewski, 2014), and multiple fetuses (McMichael et al., 2014). While there is no specific identifiable cause of CP there are several risk factors that have been identified that increase the likelihood that a brain injury would result in CP (Wu et al., 2011). Asphyxia is a possible cause however it is not very common (Matsuda et al., 2015). More commonly, CP can be caused by neuronal disorders including neural tube defects, amnionitis, metabolic disorders, vascular lesions, and coagulation disorders (Matsuda et al., 2015). Maternal autoimmune disease could also be a cause (Matsuda et al., 2015). Similarly, placental infarction is also a known risk factor for preterm infants (Vinnars, Vollmer, Nasiell, Papadogiannakis, & Westgren, 2015). Typically, it is not just one factor that results in CP but more often it is a combination of multiple risk factors and environmental triggers.

Along with the risk factors themselves, how the fetus responds to them plays a large role in the severity of the effects. In regard to brain related risk, multiple factors can be

considered, for example mild hypoxic stress and the effect of cytokines in the brain have been examined as a possible cause (Matsuda et al., 2015). Additionally, in the case of spastic CP, muscle spindles within the spastic muscle may be experiencing a chronic surplus of afferent impulses. Within the anterior horn of the spinal cord this alpha motor neuron is abnormally excited because the inhibitory impulses from the upper motor neurons are being reduced (Fukuhara, Namba, & Yamadori, 2010). It has also been noted that grey matter lesions in comparison to white matter lesions, tend to have significantly more severe motor damage, especially when the basal ganglia and thalamus are affected (Scheck, Pannek, Fiori, Boyd, & Rose, 2014). When these parts are involved it compromises the plasticity of the brain which in turn has negative consequences for cognition as well as neuromuscular functioning (Scheck, et al., 2014).

Biologically based but not necessarily brain based risk factors may include being male and having a relative with CP (O'Callaghan et al., 2013). *In vitro* fertilization (IVF) is an alternative fertility treatment option that is commonly associated with a higher maternal age and has been recognized as a risk factor for CP; though it might have to deal more with the increased chance for multiples than the procedure itself (Strömberg et al., 2002). Another possible risk factor that is currently debated is induction of labor. Studies show mixed findings, some see a correlation and others do not, but it is important to note (Elkamil et al., 2011). Therefore, more studies are needed to see the influence (if any) induction of labor might have. Is there a relationship between the actual induction processes or is it that the characteristics of pregnancies that are typically induced are also more likely to have other CP risk factors? The mode of delivery may play a role as well; it has been observed that when compared to elective Caesarean or spontaneous vaginal deliveries, breech and instrumental

deliveries had a higher risk of CP (McIntyre et al., 2013). This may be because of the increased likelihood of stress on the fetus during the birth process. Similarly, an abnormal length of time for the actual labor combined with the fetal presentation (the orientation of the fetus leaving the birth canal) puts the child at an increased risk (McIntyre et al., 2013).

Psychological factors tend to be indirect in nature when it comes to CP. The factors are not the psychological characteristics of the person with CP but rather of those that play a direct role in the care of the child/fetus such as the mother or the medical provider. It is possible that the caretaker's psychological factors may increase or decrease their likelihood of participating in high risk activities which in turn may result in increased risk for brain injury and potentially CP. Certain psychological factors may increase the likelihood that a particular risk factor or situation would occur and result in CP, but there is not a direct causal link. For example, behaviors that may be perceived as irresponsible or negligent can contribute to the likelihood a child would end up with CP (Brahams, 1991). This pertains to both expecting mothers and also medical professionals, though it is unlikely that the CP is a result of malpractice (Johnson, Blair, & Stanley, 2011). In the case of expecting mothers, activities like ingestion of teratogens such as smoking, or drugs can be considered negligent and significantly increase the risk of brain damage and therefore CP (Brahams, 1991). Through a legal lens CP is said to be preventable with adequate prenatal care. This is evident when a judge ruled in favor of a women with CP who sued her mother for negligent care which resulted in her CP (Burrell, 2014). Negligent behaviors can include and exceed the following smoking, drinking, drug use, and even careless driving while pregnant (Brahams, 1991).

While race seems to play a role, the reason for this is unknown (Durkin et al., 2015). When you compare the risk of CP with white and black children, the black children were 50% more likely to have CP (Durkin et al., 2015). Once the size of the baby for its gestational age and preterm birth rates were adjusted for this gap decreased (Durkin et al., 2015). Socioeconomic status and CP rates were negatively correlated, the lower the socioeconomic status the higher the risk for CP (Durkin et al., 2015). Along with socioeconomic status and race, immigration status can also play a role. Immigrants showed lower CP risk rates than non-immigrants, even after accounting for multiple other medical factors the results did not change (Ray et al., 2015). This may be because of the ethnicity of the immigrants and not their actual immigration status (Ray et al., 2015). Overall, biological, psychological and social factors are not mutually exclusive. A great example of this is in the Amish community. A metabolic disorder known as glutaric aciduria is perpetuated by forced inbreeding due to a small population and strict social rules. This disorder has been linked to CP and because of the inbreeding a genetic component is highlighted (Ulrich, 1997). The fact that inbreeding effects the rate of CP within a population suggests that there is a genetic component.

Management

The management of CP is extremely diverse in the fact that not only are there numerous treatment approaches outlined in the literature and more being developed each year, but also there are countless variations of severity and ability level. The key to a successful treatment program is that it must encompass a well-rounded approach that includes intervention in the biological, psychological, and social parts of life and treatment. The first to consider and arguably the most important base of an effective treatment regime is

the biological interventions. Botulinum toxin (Botox) is an endotoxin and a temporary nerve blocker that can be injected into a muscle, targeting the neuromuscular junction to improve not only the quantity but the quality of movement in extremities effected by CP (Jacobs, 2001). Botox allows a patient's muscle to be stretched by weakening the fibers (Jacobs, 2001). Botox weakens the fibers by preventing communication between the muscle and the nerve for a limited period of time (Jacobs, 2001). This treatment is especially effective in patients who are 6 years or younger with severe spasticity due to its prolonged effects in younger patients (Speth et al., 2015). When Botox is used in conjunction with occupational therapy the progress gained in goal performance is greater than that of the two treatments alone (Lidman, Nachemson, Peny-Dahlstrand, & Himmelmann, 2015). To go even further the use of stretch casting which involves strategically placing casts in such a way that stretches a muscle, braces and additional adjunct therapies can help the patient to take full advantage of the Botox treatment (Jacobs, 2001). In more minor cases of CP, the gait pattern is often an issue, increased physical therapy can help combat this and improve one's gait pattern especially after the Botox treatment has been injected (Jang, & Sung, 2014).

One of the most common treatments for spastic CP is oral medication including antispasticity medication like baclofen, diazepam, and dantrolene sodium (Jacobs, 2001). Diazepam, for example has an antagonistic effect on excitatory neurotransmitters in the central nervous system. This helps relax the muscles but may also cause sedation, one of the medicines most prominent side effects (Jacobs, 2001). Antispasticity medications can have severe side effects. For example, a reaction with dantrolene can lead to active liver failure/reversible hepatotoxicity (Jacobs, 2001). Another antagonist for excitatory neurotransmitters is baclofen. It is mentioned above as an oral medication, but it can also be

administered directly into the spinal fluid by a baclofen pump. The pump has a battery life of 3-5 years, requiring surgery to replace it. A benefit of the pump is that a much smaller dose is required than when taken orally. Though caution must be taken when weaning the child off the drug. If cessation is done too abruptly the child could experience more severe spasms, or even seizures (Jacobs, 2001).

An example of a permanent treatment option for spastic patients, is a dorsal rhizotomy which requires removing portions of the vertebrae and a lumbar laminectomy (Jacobs, 2001). This surgery reduces the sensory input from the leg muscles reducing muscle rigidity. However, spasticity can recur even after the surgery. This treatment still requires routine appointments for follow up and therapy (Jacobs, 2001). Early intervention with an orthopedic doctor and routine appointments once the diagnosis is made are essential to monitoring muscle contractures, neuromuscular scoliosis, and hip alignment very closely. In doing so, a better outcome can be achieved (Jacobs, 2001). While multiple surgeries throughout a patient's childhood was at one-point common practice, it is now known to have an optimum opening for opportunity between ages 6 and 8. It is also known that multiple surgeries put major strain on the tendons because of scarring, so surgeons try to do as much as they can in one surgery to either elongate or restrict a muscle. In addition to therapy, orthoses like splints and braces help put off the need for surgery (Jacobs, 2001).

Newer and less conventional treatments include hippotherapy. Hippotherapy is the use of horseback riding as a means to affect postural control and gait pattern (Dewar, Love, & Johnston, 2015). With a minimum of 16 hours riding time, most patients were able to achieve better postural control (Dewar, et al., 2015). There are several factors that are hypothesized to play a role in strengthening postural control. The horse's movement requires

specific hip muscles to be used in a patterned way that mimics a gait pattern and therefore normalize the motions, similar to the idea of muscle memory (Dewar, et al., 2015). An example of a more expensive and novel treatment is robot assisted gait training (RAGT). This treatment method is found to be an interesting form of therapy that has currently little to no evidence supporting the empirical effectiveness of this treatment but has the potential to grow as technology advances. Though, it is promising so far, more work needs to be done before it becomes a preferred method of treatment (Wiart, Rosychuk, & Wright, 2016). Other treatment avenues that are beginning to be investigated are balance training (Morgan et al., 2015), neuromuscular electrical stimulation (NMES) therapy (Giannasi et al., 2015), robot-enhanced repetitive treadmill therapy program (ROBERT) (Schroeder et al., 2014), and non-standardized community based workout programs (Vogtle, Malone, & Azuero, 2014).

One of the struggles associated with finding the right treatment is to find one that has positive effects with minimal to no adverse effects. Balance training is a great example of a small group based therapy that has no major adverse effects while also facilitating a positive change. In order for a person with CP to benefit from balance training they must be mobile and or able to walk. In one study, after participating in balance training activities that were specifically tailored to the individual, adults with CP showed small improvements in walking related aspects. The distance to which a patient could walk before fatigue and gait speed improved and the patient's fear of falling was also minimized (Morgan et al., 2015). Balance training should be considered as an addition to a treatment program because of the positive effects with little to no negative consequences, as well as the fact that it had a high adherence rate (Morgan et al., 2015). It is also known that group therapy tends to increase adherence rates and provide a sense of community (Allen, Dodd, Taylor, McBurney, & Larkin, 2004).

The more a patient is likely to adhere to a program the greater the likelihood they will experience positive results from that treatment.

Neuromuscular electrical stimulation therapy (NMES) is a noninvasive biologically based treatment that involves the electrical activation of motor neurons resulting in the subsequent activation of muscle motor units (Giannasi et al., 2015). It has shown promising results in its ability to strengthen the muscles treated. In a recent study the effects of NMES were evaluated specifically in relation to the masticatory muscles and sleep related variables (Giannasi et al., 2015). This study involved adults with a more severe form of CP than the subjects of the balance training therapy that was recently discussed (Giannasi et al., 2015). While this study was biological in nature, the recorded improvements may have implications on social as well as psychological aspects of the patient. Two main areas of benefit were examined; one being sleep related factors and the other related to the oropharyngeal muscles. The sleep related variables were measured using polysomnography (PSG). After two months of NMES therapy the participants showed improvements in many facets of sleep, including an increase in the total sleep time and an improved apnea/hypopnea index (AHI) (Giannasi et al., 2015). Most notably though, patients who began the study with obstructive sleep apnea (OSA) no longer had OSA at the conclusion of the study.

The other form of data collection was from electromyography (EMG) which was used to evaluate electrical activity of the oropharyngeal muscles in different positions (Giannasi et al., 2015). More specifically the masseter muscles, which are in the cheek and jaw to help with chewing. The electrical activity of the masseter muscles at rest increased by 100% (Giannasi et al., 2015). The same muscles showed a slight increase when the mouth was open as well as in the right masseter during a maximum clenching effort. The increase in muscle

tone and strength resulted in an improved chewing ability with greater comfort and efficiency as well as a visible decrease in drooling frequency (Giannasi et al., 2015). The results of this study support the idea that NMES is a viable treatment to reduce common biological issues people with more severe forms of CP often experience. It also subsequently may lessen the likelihood of certain social issues that are associated with those biological symptoms. For example, if a person is visibly drooling in public, especially if the patient is a child in school for example, the involuntary drooling may affect a peer's comfort level in approaching the person with CP. If the drooling is minimized or eradicated it may make it more likely that the person with CP will be approached by peers increasing the level of social inclusion.

Technology is without a doubt worth considering and applying to medical treatments. Robot enhanced repetitive treadmill therapy (ROBERT) is an example of how technology can be used to improve the gait patterns of patients with CP. A study evaluated the effectiveness of ROBERT in subjects with CP over a three-week period (Schroeder et al., 2014). The results of that study showed that ROBERT did have some positive effects on the patient's gait pattern for the subjects of the study with ages that ranged from 4 and 18 years old. However, the improvements were not uniform across all age groups. The younger the subject the more beneficial ROBERT therapy was for their gate pattern. While ROBERT does seem to have some positive effects, cost and availability may restrict the feasibility of this mode of therapy. More research needs to be done to justify the cost and use of resources compared to the measured benefits.

Depending on the severity of a person's CP, exercise is not only possible but plausible and encouraged. Non-standardized community based workout programs are a good way for adults with CP to safely exercise (Vogtle, et al., 2014). Voglte, Malone and Azuero

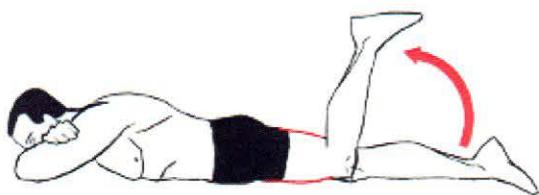
examined the effects of exercise on adults with CP. Their study consisted of multiple parts that measured the patient's pain levels and fatigue before, during (intervention phase) and after an exercise program. In order to quantify the patient's pain level, the researchers used the FACES Pain Scale during each phase and compared the three results. For ambulatory adults with CP, a significant benefit was found during the intervention phase. However, this decrease in pain diminished during the follow up phase, suggesting that exercise is only a valid form of pain management when it is continued regularly (Vogtle, et al., 2014). The same can be said for the level of fatigue experienced which was measured by the PedsQL Multidimensional Fatigue Scale (Vogtle, et al., 2014). This study's results suggest that while exercise can help ease pain and fatigue in adults with CP, it does not have lasting effects unless the exercise is continued.

On the other hand, psychological interventions play a specific complimentary role in the treatment of CP. Treatments from a psychological approach can make or break patient's compliance and their willingness to adhere to their typically rigorous and unpleasant treatment programs. Treatment programs are only effective if they are adhered to consistently. Home programs are helpful in facilitating adherence because of their convenience, the patient doesn't have to go anywhere. Home programs are one of the most effective ways to combat contractures and muscle tightening. With the support of their child's medical team, a parent can continue therapy at home maximizing the effects of the therapy (Novak, 2011). By making it a part of their daily routine whether in play at young ages or just throughout the day this is one way a parent of a child with CP can feel like they have more control and can be of service to their child. Common at home exercises include

knee and hip flexion, hip adduction, and ankle dorsiflexion shown in figures 1-4 (Jacobs, 2001).

Figure 1.

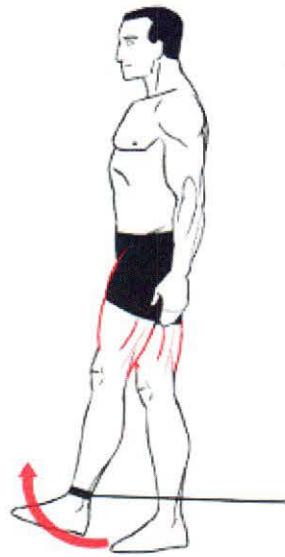
Figure 1 is an example of knee flexion that can be practiced at home. There are many variations assisted and unassisted of this stretch, but the photo below is a generic version that demonstrates the end result of the movement.



(<http://www.pt-helper.com/ankle---foot.html>)

Figure 2.

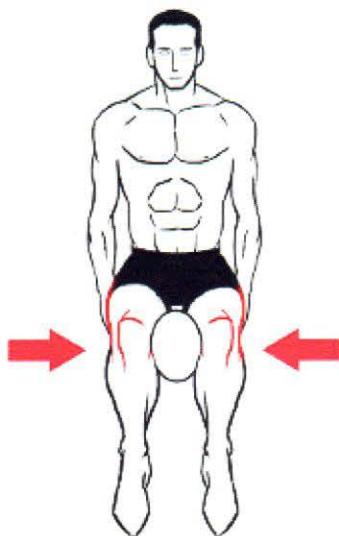
Figure 2 is an example of hip flexion. This photo features a resisted variation but for patients with CP the resistance band may not be used, at least not right away.



(<http://www.pt-helper.com/ankle---foot.html>)

Figure 3.

Figure 3 is an example of the hip adduction stretch. This is a variation of this stretch that may be easier for patients with CP because it does not involve as much balance as the standing variation does. The patient simply squeezes the ball that is placed between their legs.



[\(<http://www.pt-helper.com/ankle---foot.html>\)](http://www.pt-helper.com/ankle---foot.html)

Figure 4.

Figure 4 shows an example of ankle dorsiflexion. The patient simply raises their heel off the ground. While this may seem quite simple, for those with CP this motion takes concentration and practice to master.



[\(<http://www.pt-helper.com/ankle---foot.html>.\)](http://www.pt-helper.com/ankle---foot.html)

The psychological wellbeing of a patient with CP is vital in ensuring the best outcomes of treatment. In respect to the BPS model, depressive symptoms as a result of a CP diagnosis can seemingly be best reduced by moderating the following coping mechanisms: task persistence, catastrophizing, and resting (Jensen, Engel, & Schwartz, 2006). By

increasing a patient's task persistence and minimizing catastrophizing and resting the patient can develop productive coping mechanisms. Task persistence is quite literally one's willingness to persevere on a task and see it to fruition when the resolution is not immediate. Catastrophizing is when a patient has irrational thoughts that depict a situation as being worse than it actually is. The level at which a patient catastrophizes can be measured by the Coping Strategies Questionnaire (CSQ) (Jensen, et al., 2006). The way health professionals combat catastrophizing thoughts is by teaching the patient to identify when they are having these irrational thoughts and use logic to disprove the reasoning behind them (Jensen, et al., 2006). This skill takes patience and practice to master but once it is mastered, it dramatically reduces the risk of depression and can subsequently improve one's view on their quality of life (Jensen, et al., 2006). Similarly, knowing when to rest as a result of pain and when to persevere despite of pain is equally as important (Jensen, et al., 2006). Resting prematurely prevents or limits patient progress with many therapies, especially since a large portion, if not all, people with CP experience chronic or frequent pain (Riquelme, et al., 2014). On the flip side however, not resting when in too much pain can increase the patient's risk for injury. When these cognitive errors are minimized the patient's overall quality of life improves dramatically (Jensen, et al., 2006).

Adults with CP tend to perceive life as less predictable, manageable, and meaningful compared to people without CP (Jahnsen, Villien, Stanghelle, & Holm, 2002). Factors that affect these feelings are: marital status, education level, fatigue, and life satisfaction (Jahnsen, et al., 2002). Participation in leisure activities is an important part of treatment for adults as well as children. Leisure activities are a way to incorporate beneficial therapy into a more casual setting. For children, childlike activities help to allow patients with CP feel like

they fit in. Participation in leisure activities is vital to social skills as well as developing independence (Majnemer et al., 2008). At the age of two and a half there are different levels that can predict a child's participation in leisure activities. Environmentally, the type of day care is important. At the child level, social skills and movement aptitude are large predictors. Lastly, the restrictiveness or lack thereof, from the family's views may affect the child's environment (Bult et al., 2013). A parent of a child with CP should be treated as an inclusive part of their child's medical team to optimize the beneficial potential of the child's home environment (Hemsley, Balandin, & Togher, 2008). Often, treatment programs include an at home component that requires the caregiver to take the lead and facilitate certain activities. If the parent or caregiver is not included as a part of the medical team, they may not be confident or knowledgeable enough to conduct the at home therapies accurately. The same can be said for adult leisure activities. Not only do adult group exercise programs facilitate inclusion they create a feeling of enjoyment which makes the adult with CP more likely to adhere to the workout schedule, and in turn, create long lasting benefits (Allen, et al., 2004). Social support, fatigue, mental health, and pain have all shown to be positively affected by a lifestyle intervention for young adults and adolescence with CP, combined, these things can dramatically increase one's quality of life (Slaman et al., 2015).

Social and psychological aspects tend to go hand in hand. It tends to be easier to draw the line of distinction between the biological and the psychosocial aspects. It is important to note that while psychological and social factors are usually quite similar they are different entities that work together to enhance the effects of the other. No single social factor can influence all aspects of gross motor function. However, with an abundance of treatment options the parent's education level does seem to affect the treatment choice (Rackauskaite,

Uldall, Bech, & Østergaard, 2015). Rackauskaite, Uldall, Bech, and Østergaard (2015) found that the less amount of time a parent spent in school the more willing they were to accept orthopedic surgery for the milder cases of CP which is not recommended for optimal success. In severe cases of CP, the longer the parent spent in school the less likely they were to do frequent therapy, due to their understanding of the circumstances and the limitations of treatment outcomes in severe CP. Choosing the right type of therapy is vital in the overall wellbeing of the child. The wrong treatment program can put unnecessary strain on the child and result in low morale and unfavorable outcomes. Therefore, it is imperative that the parent or caregiver of the child should be treated as an inclusive part of the medical team (Hemsley, et al., 2008).

Romantic relationships are a vital part in any developing teen and young adult's life. It is safe to say that while this is difficult for most young people it is especially so for young adults with CP. Data shows that for young adults with CP, more females are involved in romantic relationships than males (Wiegerink, Stam, Ketelaar, Cohen-Kettenis, & Roebroeck, 2012). Wiegerink, Stam, Ketelaar, Cohen-Kettenis, and Roebroeck (2012) found that while gross motor function does not play a role in romantic relationships, it does factor in to sexual activities. Parents are encouraged to put an emphasis on self-esteem and self-efficacy to increase the likelihood and quality of romantic relationships. While adolescences with CP have lower rates of experience with sexual activities when compared to their counterparts at the same age without CP, the teenagers with CP have those experiences just slightly later in life. Participation in peer groups plays a big role in these statistics. Peer groups and leisure activities provide an outlet for communication, dating opportunities, and are vital for the development of social skills and independence (Majnemer et al., 2008).

Integration

It is essential to look at CP through a biopsychosocial lens. A patient with CP must maintain a balance in all three areas of the BPS model, allowing for early diagnosis and overall better management of the disease. While there is no one single treatment course or cure, it has been strongly supported by research that to achieve maximum results a treatment regimen must contain biological interventions to help with mobilization, psychological interventions to maintain motivation and adherence, and social support such as group exercise classes to promote inclusion. A treatment plan that includes physical therapy (PT), counseling, and group exercise is a prime example of a biopsychosocial treatment approach. Physical therapy strengthens and stretches the muscles allowing for more mobility and therefore better ability to participate in activities. The counseling may help improve emotional stability, which gives the patient more confidence to participate in group exercise. This can help adherence by motivating the patient to move, all while making friends resulting in a social network and a better overall quality of life. Aspects of the BPS model can be integrated to illuminate optimal treatment pathways, but it can also provide some insight into the risk factors that may lead to a person having CP. A negative example of how the BPS areas can interact is how lower socioeconomic status equals a higher probability of poor prenatal care, less risk awareness, as well as non-ideal birthing situations which may increase the risk of labor complications and possibly result in or increase the risk of CP.

The BPS model's advantages do not have to be limited to specifically relating aspects of biology, psychology, and society. Rather, the fundamental idea of the BPS model is to facilitate and call for medical professionals and researchers to look beyond their area of expertise and tackle disease from every angle possible, even if that angle is not a traditional

biomedical approach. A great example of this is a study that was done examining the relationship between drawings and aspects of CP in children with CP (Chong, Mackey, Stott, & Broadbent, 2013). This study involved having children with CP draw pictures of themselves walking. The pictures were then examined looking for and measuring certain aspects of the drawing. Art and therapy used to be an unlikely pairing but more recently data is beginning to show the potential insights art can give medical professionals. One of the things the researchers measured in the child's drawings was the figure height (Chong, et al., 2013). The researchers found that the children who drew larger figures had shorter times in the walking test (Chong, et al., 2013). The longer period of time a child could walk the better, with shorter times possibly being associated with less mobility, walking ability, and increased pain (Chong, et al., 2013). Although the larger drawing did not make the child do more poorly on the walking test directly, the drawing may be thought of as a physical representation of their own perception of their CP. It is possible that the larger figure can be associated with the child viewing their diagnosis as a large part of their life and therefore they have a tendency to focus on it more and to allow their CP to limit/consume their lives (Chong, et al., 2013). On the other hand, data showed that children who drew smaller figures tended to be those who experienced more frequent and more severe pain (Chong, et al., 2013). One of the major limitations of this study is that it is hard to identify what the kids were thinking when they drew their pictures and what was influencing the correlations. Nevertheless, there does seem to be valuable information gained from having children participate in this activity and being that little time and resources are needed to complete this task the cost versus benefit may in fact be worth it more times than not, even if it is simply as a form of emotional insight where communication barriers exist. If a child has a hard time

explaining their feelings toward their diagnosis, drawings may serve as a window into their thoughts. The drawing not only act as a starting point for conversation but may also serve as a physical manifestation of the child's feelings.

The other aspects of the drawings that were evaluated dealt with the social and environmental aspects of the BPS model. First, the location of the drawing was important. Children who drew their figure inside of a building tended to cover less distance when compared to children who drew their figure outdoors (Chong, et al., 2013). This may have to do with the idea of a least restrictive environment (LES). This is an ideal to strive for and relates to the location indicated in the drawing because if a child drew their figure inside of a building this may mean that this is the location the child is most familiar with or exposed to. This makes sense being that some children with CP have limitations and restrictions that if they are not actively combatted may interfere with the outside exposure that child receives. Second, one in five children drew other people walking with them in their drawing (Chong, et al., 2013). The data showed that children who drew other people in their picture were not as negatively affected by their CP diagnosis emotionally. They also had longer walking distances in the walking test when compared to those who did not include other people in their drawing. The researchers associated the presence of other people in the drawing with the child having other people as a support system in real life (Chong, et al., 2013). It is strongly supported by the medical community that having a strong support system is vital in the treatment process and the patient's quality of life. Interestingly, there was no significant association between figure size and participant age which decreases the likelihood that the variations in the drawings could be associated with drawing ability. This study is an unconventional perspective but that is precisely why it fits so well with the BPS model. This

study demonstrated how a child's perceptions of their diagnosis can shape or be impacted by their actual ability and perhaps overall quality of life (Chong, et al., 2013).

One of the advantages of the BPS model is that associations can be thought of as cyclical, bidirectional, or multifaceted in nature. For example, a child with CP has several factors that may contribute to the likelihood that they participate in activities and the frequency at which they do so. A study by Parkes, McCullough, & Madden, (2010) looked at what those factors might be in an attempt to minimize the effects of the identified limiting factors. One of the more straight forward findings was that the children with more severe forms of CP had lower rates of participation (Parkes, McCullough, & Madden, 2010). This is not surprising because the children with more severe forms of CP have more obstacles, both physically and intellectually, that they must overcome to participate in most activities. Similarly, the data suggested that impairments in feeding and gross motor function played a large role in determining the likelihood that the child would participate in activities (Parkes, et al., 2010). Overall, children with CP participated in activities involving relationships, communication, and fitness at higher rates than they participated in school, personal care, and mobility activities (Parkes, et al., 2010).

As previously mentioned, people with CP are at a higher risk for experiencing not only higher levels of pain but also chronic pain due to their sensitivity to it (Yamaguchi, Perry, & Hines, 2014). Pain is an important factor in determining a person's perception of their quality of life as well as the reality of their quality of life (Parkes, et al., 2010). Increased levels of pain even in more mild forms of CP can place limitations on the activities that the child with CP can participate in (Parkes, et al., 2010). Even though typically there is a positive correlation between severity and pain, sometimes people with mild forms of CP

experience higher levels of pain than those with more severe versions of CP (Parkes, et al., 2010).

An interesting facet of the findings from Parkes, McCullough, and Madden's 2010 study on the everyday lives of those with CP showed a correlation between parenting stress and community participation. Higher rates of parental stress were associated with lower participation rates in community activities such as cub scouts or girl scouts (Parkes, et al., 2010). Being that increased participation in community activities can have positive benefits for a person's quality of life, the decreased likelihood of participation of children with parents who have high levels of stress suggests that a parent's stress level can negatively affect the child's quality of life in multiple ways. Participating in community activities and social inclusion is exemplified in this study (Parkes, et al., 2010). This also shows how something that is completely unrelated to the diagnosed person's biology can affect the course of the disorder. For example, adherence and self-efficacy play a role in the effectiveness of treatment. If the patient does not live in a supportive environment this may restrict or inhibit these factors and decrease the likelihood of an optimal treatment outcome. Which is why it is important to consider aspects outside of the biological realm when painting a full medical picture.

Future Directions

CP is a prime example of a disorder that requires more than the current medical model. Even with the perspective of the BPS model all aspects of causality and treatment are not accounted for. This is evident in the fact that we still struggle to identify causes and treat the resulting disorder in an efficient and comprehensive way. Notably, the BPS model does seem to allow for the most comprehensive understanding of CP to date. The biopsychosocial

ecological paradigm (Stineman, et al., 2010) pertains to CP even more specifically. The major difference between the BPS model and the biopsychosocial paradigm is that the latter includes the aspects of a person's environment more explicitly as well as creates more definitive and specific levels or hierarchies specifically related to problems of mobility (Stineman, et al., 2010). In this model there are four main spheres, the mind, body, society, and the physical world. Along with the four spheres there are also five levels of functioning that are used to define aspects of disease. The five levels are as follows: "cellular, body tissue, organ or system, person, and environmental experience" (Stineman, et al., 2010, p. 10). This new model should be an avenue that future research and further studies should investigate. It is possible that just as through the lens of the BPS model aspects of CP are revealed, even more intricacies could be uncovered if CP is evaluated through the biopsychosocial ecological paradigm.

More research should be dedicated to finding definitive and detectable causes, and therefore allowing a better and more specific treatment plan to be recommended for each case of CP. The diagnosis and treatment of CP involves a complex interrelated web of biopsychosocial pathways. The key to a successful management program is to find the combination that fits the patient's unique situation while also being malleable enough to adapt with them as they grow. More research should also be devoted to developing these pathways systematically as they relate to prevention, diagnosis, and treatment to create a comprehensive understanding of how all aspects are related.

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